

## Reliability and factor structure of the Hospital Anxiety and Depression Scale in a polytrauma clinic

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**Abstract**—The Hospital Anxiety and Depression Scale (HADS) is a brief self-report measure of anxiety and depression symptoms. This study examined the internal consistency and factor structure of the HADS among Veterans in a polytrauma/traumatic brain injury clinic. The sample consisted of 312 Veterans. A confirmatory factor analysis of the depression and anxiety subscales showed, not surprisingly, that the two factors were highly correlated ( $r = 0.70$ ). Goodness of fit statistics for the two-factor model were acceptable (root mean square error of approximation = 0.06, comparative fit index = 0.94). The HADS demonstrated very good reliability overall ( $\alpha = 0.89$ ) and for the individual subscales ( $\alpha = 0.84$ ). This study supports the use of the HADS as a screen for depression and anxiety in the assessment of mild traumatic brain injury in a Veteran population.

**Key words:** anxiety, concussion, confirmatory factor analysis, depression, factor structure, internal consistency, mild traumatic brain injury, polytrauma, reliability, self-report.

### INTRODUCTION

Because of overlapping symptoms and comorbid conditions, when assessing soldiers and Veterans with suspected traumatic brain injury (TBI) we should also

assess other conditions. Although a comprehensive evaluation of all psychiatric conditions is not usually practical in a time-limited TBI evaluation, we should screen for conditions that commonly co-occur with or mimic symptoms of TBI. Among the most commonly encountered of these conditions are anxiety and depression [1–3]. This study examines the psychometric properties of a brief self-report measure of anxiety and depression, the

**Abbreviations:** BAI = Beck Anxiety Inventory, BDI-2 = Beck Depression Inventory-II, CFA = confirmatory factor analysis, CFI = comparative fit index, HADS = Hospital Anxiety and Depression Scale, HADS-A = Hospital Anxiety and Depression Scale anxiety items, HADS-D = Hospital Anxiety and Depression Scale depression items, HAM-D = Hamilton Depression Rating Scale, mTBI = mild traumatic brain injury, PTSD = posttraumatic stress disorder, RMSEA = root mean square error of approximation, SCID-IV = Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition, TBI = traumatic brain injury, VA = Department of Veterans Affairs.

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**<http://dx.doi.org/10.1682/JRRD.2015.05.0088>**

Hospital Anxiety and Depression Scale (HADS) [4], in a sample of Veterans evaluated in a Department of Veterans Affairs (VA) polytrauma/TBI clinic. The psychometric measures of the HADS have not been previously investigated in this sample.

The HADS is among several brief measures that have been developed to screen for anxiety and depression. Other, more widely used instruments include the Beck Anxiety Inventory (BAI) [5], the Beck Depression Inventory-II (BDI-2) [6], and the Hamilton Depression Rating Scale (HAM-D) [7]. Brief self-report measures can be useful for quantifying symptoms at a single point in time or tracking changes in symptoms over time. Although such instruments were not developed to diagnose psychiatric conditions, they are often used to supplement other assessment methods in settings where there is an emphasis on brevity. Both the BAI and BDI-2 are 21-item inventories that assess physical, affective, and cognitive symptoms of anxiety and depression. The BAI takes approximately 5 min to complete, and the BDI-2 takes approximately 5 to 10 min. Internal consistency of these measures is very good to excellent, ranging from 0.84 to 0.94 [8–10]. The HAM-D is a 17- to 29-item clinician-administered test that focuses on the cognitive and affective aspects of depression. Internal consistency of the HAM-D is adequate to very good, ranging from 0.77 to 0.81 [11]. Although each of these measures has clinical utility, each has weaknesses that are not apparent in the HADS.

The HADS was developed in 1983 as a brief, portable self-report measure of anxiety and depression [4]. Because the HADS was intended for use with medical patients among whom physical problems are common, the items of the HADS deemphasize physical or somatic symptoms, such as decreased energy, and emphasize cognitive symptoms. Unlike the HAM-D, the HADS addresses both depression and anxiety and does not require a clinician for administration. The HADS has fewer items (i.e., 14) than the aforementioned measures and thus takes less time for patients to complete, approximately 5 min. Scoring the HADS is simple, and similarly to the aforementioned measures, takes just a few minutes. The HADS is also freely available within the public domain. These features make the HADS attractive to clinicians and researchers who need a rapid, efficient assessment of psychiatric symptoms when there is not enough time to administer multiple, more comprehensive,

or time-consuming instruments, such as the BAI, BDI-2, and the HAM-D [5–7].

The HADS is straightforward and requires minimal time for administration and scoring, but, as with any assessment instrument, its utility rests with its psychometric properties. The anxiety and depression subscales of the HADS have been found to have at least adequate internal consistency, with reliability estimates exceeding 0.70 among nondiagnosed individuals [12–13], medical patients [14–23], and psychiatric patients [24–25], which is similar to reliability estimates reported for the BAI, BDI-2, and HAM-D. Nevertheless, this instrument has not been as thoroughly studied in a head injury population. Factor analytic studies have examined whether the items of the HADS separate into distinct factors. Flint and Rifat used principle components analysis to determine that the HADS separated into two distinct factors in older patients with major depression [25]. A review of 747 papers reporting on studies of samples from mostly hospital clinics, but also samples from the general population, general practice, and psychiatric patients, found that most demonstrated the validity of the HADS using a two-factor solution, mainly principle components analysis, consisting of HADS anxiety items (HADS-A) and HADS depression items (HADS-D) [26]. The Cronbach alpha for HADS-A ranged from 0.68 to 0.93 (below adequate to excellent) with a mean of 0.83 (very good). Cronbach alpha for HADS-D ranged from 0.67 to 0.90 (below adequate to excellent) with a mean of 0.82 (very good). These coefficients are similar to those reported for the BDI-2, BAI, and HAM-D. Included in the review was a confirmatory factor analysis (CFA) by Dunbar et al. who tested different models and found that a three-factor model provided the closest fit across three age groups (18–19, 39–40, and 58–59 yr old) [27]. However, a two-factor model also showed goodness of fit statistics that were similar to the three-factor model. Measures of goodness of fit for the two-factor model were acceptable as follows: comparative fit index (CFI) ranging from 0.92 to 0.94, and root mean square error of approximation (RMSEA) ranging from 0.04 to 0.06.

Several studies have confirmed the diagnostic validity of the HADS. In perhaps the most pertinent study to the current investigation, Whelan-Goodinson et al. examined the diagnostic validity of the HADS among patients with mild to severe TBIs using the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (SCID-IV) as a criterion

measure for anxiety and depression [28]. Depending on whether mild or severe cut offs were employed, 57 to 92 percent of those scoring in the anxious range on the HADS-A were determined to have an anxiety disorder according to the SCID-IV. Conversely, 72 to 83 percent of the sample scoring in the nonclinical range on the HADS-A did not meet SCID-IV criteria for an anxiety disorder. Similar results were obtained with the HADS-D: 81 to 100 percent of participants who endorsed depression on the HADS-D met criteria for depression and 69 to 82 percent of individuals scoring in the nonclinical range on the HADS-D did not meet criteria for depression. Similar diagnostic validity statistics have been found in samples of patients with medical disorders [22,29–33] and mixed psychiatric disorders [21,34].

The current study seeks to evaluate the utility of the reliability and factor structure of the HADS among Veterans in a polytrauma/TBI clinic. This undertaking is important because an increasing number of Veterans are reporting postconcussive symptoms. Given the significant overlap between postconcussive symptoms and psychiatric symptoms, brief screening for psychiatric distress is a necessary part of a thorough mild TBI (mTBI) evaluation. First, the HADS will be subjected to a CFA to see if the items can be separated into distinct scales of depression and anxiety. Second, the existing anxiety and depression scales will be examined using the Cronbach alpha to evaluate internal consistency. A statistic exceeding 0.70 will be deemed adequate for a brief screening instrument, values around 0.80 will be very good, and values of 0.90 and above will be excellent [35–36].

## METHODS

### Participants

We conducted a retrospective review of deidentified data from Veterans who underwent neuropsychological testing as part of a comprehensive polytrauma/TBI evaluation. The majority of Veterans were referred to the TBI clinic after screening positive for a possible TBI using a standard VA clinical reminder that broadly assesses risk factors and symptoms of a head injury. Most individuals had not previously received mental health care. A total of 312 Veterans completed the HADS as part of neuropsychological testing, and 23 of these Veterans were seeking compensation for suspected mTBI that occurred during their military service. Data from many of these partici-

pants have been previously reported in research examining self-reported cognitive symptoms and performance validity of a digit span test and a Rey Fifteen-Item Memory Test [37–40]. Participants were excluded if they sustained a head injury of more than mild severity (i.e., greater than 30 min loss of consciousness, greater than 24 h posttraumatic amnesia) or presented non-TBI central nervous system pathology, such as stroke or epilepsy. Participants over 50 yr of age were excluded from the study because the majority of the Veterans evaluated in the clinic are younger Veterans returning from the recent conflicts in Iraq and Afghanistan, so we wanted to limit our investigation to this population. Additionally, we wanted to exclude the possible confounding effect of neurodegenerative disorders. The mean age was 29.2 yr ( $\pm 7.0$ ), with 12.8 yr ( $\pm 1.4$ ) of education. Six individuals did not report their years of completed education. The sample was predominantly male (95.5%).

### Measures

The HADS consists of 14 items: 7 designed to measure depression and 7 designed to measure anxiety [4]. Items are rated on a Likert-type scale from 0 to 3. Total scores are calculated for the depression and anxiety items. Scores of 8 to 10 indicate mild symptoms, scores of 11 to 14 indicate moderate symptoms, and scores of 15 or higher indicate severe symptoms. Reliability of the total scale as well as the HADS-A and HADS-D subscales were assessed.

### Procedure

The HADS was administered as part of a larger screening battery. Participants consisted of consecutive referrals to the polytrauma/TBI clinic as well as deidentified archived data, which was analyzed retrospectively. Following completion of the HADS and other measures, the other required components of the evaluation were completed, including a thorough clinical history, psychosocial needs assessment/psychoeducation, and neurologic examination. If clinically significant mental health symptoms were present during the evaluation and the participants were interested, they were referred to the relevant clinic for further mental health assessment and/or treatment.

### Statistical Analysis

Statistical analyses were computed using IBM SPSS Statistics, Windows, Version 22 (IBM Corp; Armonk, New York) The data were screened for univariate and

multivariate normality, linearity, and homoscedasticity. These analyses showed that univariate assumptions were met. The means, standard deviations, skewness, and kurtosis statistics for the 14 items are presented in the **Table**. Mahalanobis distance and Mardia coefficient of multivariate kurtosis were calculated to assess multivariate normality. Mardia coefficient = 13.5, which exceeds the critical ratio of 5.6 indicating a violation of multivariate normality. Mahalanobis distance exceeded the chi-square of 27.7 ( $df = 13$ ),  $\alpha = 0.001$  for 15 cases. These cases did not appear to be outliers and were retained for further analyses. A Bollen-Stine bootstrapping technique was employed to account for the violation of multivariate normality, and the results were only slightly different from using maximum likelihood estimation. Because maximum likelihood estimation has been shown to be relatively robust to violations of normality with large samples with no missing data and Bollen-Stine bootstrapping does not include adjusted goodness of fit measures, results are presented using maximum likelihood estimation [41]. A CFA was conducted to determine whether the two-factor structure holds in the current sample. Although there is no single criterion for assessing goodness of fit, general convention suggests the RMSEA should be less than 0.08 for acceptable fit and less than 0.05 for excellent fit [42–43]. The CFI should be greater than 0.90 for acceptable fit and greater than 0.95 for close

fit [44]. Internal consistency of the HADS total scale, HADS-D, and HADS-A was examined using the Cronbach alpha.

## RESULTS

The range of possible scores for each subscale is 0 to 21, with a total possible 42 points. Scores of 8 to 10 indicate mild symptoms, scores of 11 to 14 indicate moderate symptoms, and scores of 15 or higher indicate severe symptoms. The mean score on the anxiety scale for this sample was 12.09 ( $\pm 4.31$ ), which is in the moderate range. Scores for 48 (15.38%) individuals were not clinically meaningful. Scores for 66 (21.15%) individuals indicated mild symptoms of anxiety, scores for 91 (29.17%) individuals indicated moderate symptoms, and scores for 107 (34.29%) individuals indicated severe symptoms.

The mean score on the depression scale for this sample was 8.87 ( $\pm 4.54$ ), which is in the mild range. Scores for 119 (38.14%) individuals were not clinically meaningful. Scores for 83 (26.60%) individuals indicated mild symptoms of depression, scores for 75 (24.04%) individuals indicated moderate symptoms, and scores for 35 (11.22%) individuals indicated severe symptoms.

Research and clinical practice have shown that anxiety and depression are related, have overlapping features, and often co-occur, so the two latent factors of anxiety and depression were allowed to correlate in the CFA. The model is depicted in the **Figure**. All of the paths in the model were statistically significant. The model chi-square was statistically significant, indicating that the model's predictions significantly deviated from the actual data pattern,  $\chi^2 (76) = 168.85$ ,  $p < 0.001$ . The RMSEA fit statistic was acceptable (RMSEA = 0.06), and the 90 percent confidence interval ranged from 0.05 to 0.08. The CFI was also acceptable (CFI = 0.94).

As expected, the two factors were highly correlated ( $r = 0.70$ ). All of the paths from the latent to the observed variables were significant. The total HADS, HADS-A, and HADS-D all had very good reliabilities, the Cronbach alpha is 0.89 (approaching excellent) for the total scale and 0.84 for each of the subscales.

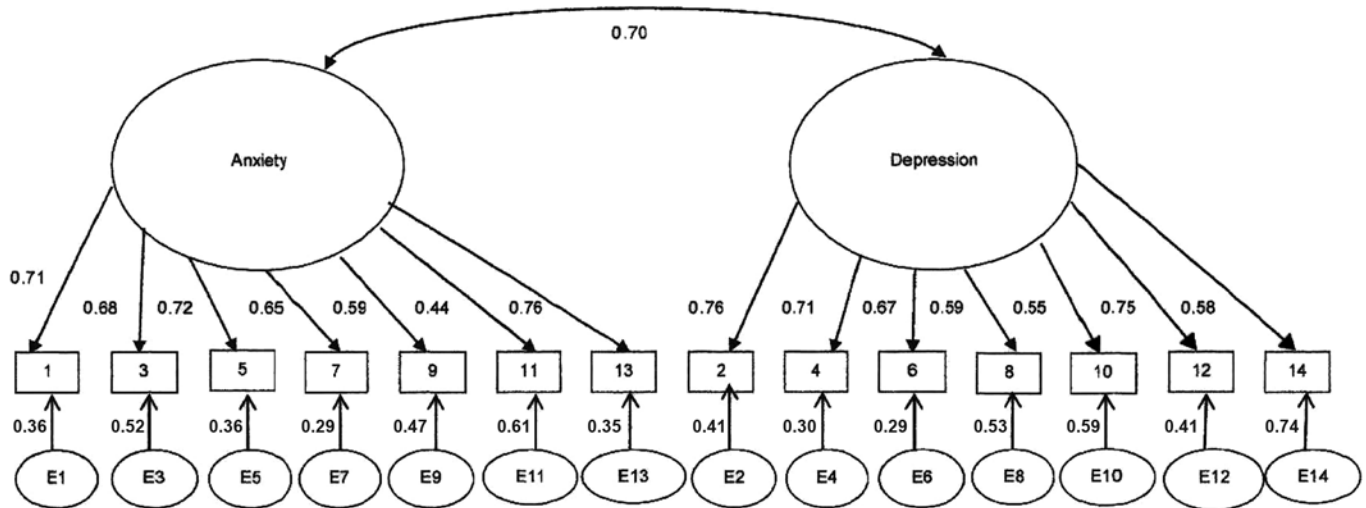
## DISCUSSION

This study focused on determining the psychometric properties of the HADS in Veterans undergoing evaluation

**Table.**

Means, standard deviations, skewness, and kurtosis of Hospital Anxiety and Depression Scale items.

Item	Mean	Standard Deviation	Skewness	Kurtosis
1	2.04	0.86	−0.41	−0.78
2	1.43	0.99	0.30	−0.96
3	1.73	0.99	−0.27	−0.96
4	0.94	0.79	0.30	−0.81
5	2.01	0.87	−0.47	0.60
6	1.23	0.73	0.01	−0.45
7	1.73	0.71	−0.22	−0.06
8	1.65	0.90	−0.00	−0.84
9	1.17	0.86	−0.43	−0.37
10	1.12	0.92	0.28	−0.91
11	1.94	0.87	−0.41	−0.60
12	1.33	0.97	0.15	−0.97
13	1.47	0.90	0.06	−0.77
14	1.16	1.05	0.57	−0.86



**Figure.**

Factor structure of the Hospital Anxiety and Depression Scale. Large ovals have latent variables. Item numbers in boxes are observed variables. Numbers next to arrows from latent to observed variables are the standardized estimated factor loadings. Numbers next to arrows from observed variables to error terms (E) are residual variances. Double-headed arrow indicates correlation between latent variables (anxiety and depression; 0.70).

in a polytrauma/TBI clinic. The results showed that the two-factor structure of the HADS holds in a sample of Veterans with suspected mTBI. The model fit statistics obtained in the current study were within the ranges found by Dunbar et al. in their two-factor models [27]. Although there was significant correlation between indices of anxiety and depression, these factors were dissociable. This result is important because it allows clinicians to follow up with patients on specific symptoms of anxiety or depression and refer them to the appropriate empirically supported treatments. Given the overlap between the anxiety items on the HADS with posttraumatic stress disorder (PTSD) symptoms and the high comorbidity of PTSD in polytrauma samples, it is possible that a different factor structure may emerge if separate models were tested for participants with and without PTSD. Unfortunately, this analysis could not be completed given the current sample size and lack of definitive diagnosis of PTSD [45]. Future research with larger samples may improve the fit of the two-factor model.

The current HADS-A and HADS-D reliability estimates were very similar to the mean scores reported in a review study [26]. Additionally, this study demonstrated that the reliability estimates of the HADS scales were comparable to those of the BAI and BDI-2 in other studies, and the HADS was more reliable than the HAM-D

[8–11]. The HADS, however, contains one-third the items of the combined BAI and BDI-2. In settings where efficiency is stressed, such as TBI clinics, the shorter yet equally reliable HADS may be preferable for identifying symptoms of depression and anxiety that may warrant further evaluation by mental health professionals.

In this sample, on average, individuals reported moderate symptoms of anxiety and mild symptoms of depression. The majority of individuals indicated clinically meaningful scores of depression and/or anxiety. This result illustrates the clinical relevance of assessing symptoms of anxiety and depression in individuals undergoing evaluation for mTBI. Often, despite self-reported residual postconcussive symptomatology, the most salient symptoms among Veterans with histories of mTBI are emotional in nature [46]. For this reason, having an instrument such as the HADS is psychometrically useful for serial monitoring of these symptoms. Additionally, the factor structure of the HADS can give direction to clinicians and serve as a way to begin a conversation about mental health symptoms with patients who may not view their difficulties as emotional. Following this initial discussion in a VA polytrauma/TBI clinic, clinicians can refer Veterans for more targeted mental health services if warranted.

The HADS offers an efficient, structured method for gathering self-report data on anxiety and depression. The

HADS is typically used in settings where assessment of anxiety and depression must be brief and data from the present sample, a VA polytrauma/TBI clinic, indicates that the anxiety and depression scales are of adequate reliability for brief assessments, screening, and most research purposes. Like all brief self-report instruments, the HADS has inherent weaknesses that must be compensated for by other assessment methods, such as clinical interview, behavioral observation, informant report, medical record review, and/or psychological testing. Anxiety and depression are common features in many mental and medical disorders; therefore, a thorough clinical history must be taken to determine whether symptoms are better accounted for by other conditions. Conversely, the items of the HADS relate to depression and anxiety in a general way and do not map directly onto any specific disorders in the fifth edition of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders [47]. Another limitation is that the present study did not examine the convergent and divergent validity of the HADS. Future research can address this concern.

The brevity of the HADS may be regarded as a weakness because brief instruments typically yield lower reliability estimates than do longer instruments. It is a well-known phenomenon that, provided the items are of similar validity, longer instruments are more reliable than shorter ones. It can be argued, however, that longer self-report measures have a point of diminishing returns, whereby little incremental information is gained from additional items. Although some may argue that longer instruments are better, this study has shown that despite its brevity, the HADS has psychometric properties comparable to longer instruments used to screen for anxiety and depression among Veterans in a polytrauma/TBI clinic.

## CONCLUSIONS

The HADS is a brief, clinically useful measure of anxiety and depressive symptoms found to have very good reliability and two related, but distinctive, factors in a sample of young Veterans in a polytrauma/TBI clinic.

## ACKNOWLEDGMENTS

### Author Contributions:

*Study concept and design:* R. J. Spencer, L. L. Drag, L. A. Bieliauskas.  
*Acquisition of data:* L. L. Drag, P. H. Pangilinan.

*Analysis and interpretation of data:* L. Boxley, J. M. Flaherty, R. J. Spencer.

*Drafting of manuscript:* J. M. Flaherty, R. J. Spencer.

*Critical revision of manuscript for important intellectual content:*

L. Boxley, J. M. Flaherty, R. J. Spencer, L. L. Drag, P. H. Pangilinan, L. A. Bieliauskas.

**Financial Disclosures:** The authors have declared that no competing interests exist.

**Funding/Support:** This material was unfunded at the time of manuscript preparation.

**Institutional Review:** The parent study was approved by the Institutional Review Board at the VA Ann Arbor Healthcare System. Informed consent was not required because this was a retrospective study of de-identified data.

**Participant Follow-Up:** Because this was a retrospective study, participants will not be informed of the results. The authors have no plans to notify the study subjects of the publication of this article because of a lack of contact information.

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Submitted for publication May 20, 2015. Accepted in revised form December 16, 2015.

This article and any supplementary material should be cited as follows:

Boxley L, Flaherty JM, Spencer RJ, Drag LL, Pangilinan PH, Bieliauskas LA. Reliability and factor structure of the Hospital Anxiety and Depression Scale in a poly-trauma clinic. *J Rehabil Res Dev*. 2016;53(6):873–80.  
<http://dx.doi.org/10.1682/JRRD.2015.05.0088>

